Why 1.5°C?

Description

Since the Paris Agreement at COP21 in December 2015, the 1.5°C target as a limit for global warming is much discussed, but why 1.5°C?

Where did the 1.5°C target come from?

The concept of identifying a threshold for climate change has existed for over 30 years. Article 2 of the 1992 United Nations Framework Convention on Climate Change (UNFCCC) states:

“The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.”

A key consideration is around the definition of the term ‘dangerous’ in this context of anthropogenic climate change. A vast array of scientific research has been conducted looking at a wide range of topics considering the environment (coral bleaching, ice sheet stability, food and water security, forests & vegetation) and also the point at which climate tipping points could occur. Through the 1990s and early 2000s several nations determined that a good target with respect to Article 2 commitments and considerations around climate vulnerabilities was 2 °C above pre-industrial levels, to prevent worsening and potentially irreversible effects of climate change. This 2 °C target was agreed as a goal at COP16 in Cancun.

Research commissioned by the Alliance of Small Island States (AOSIS), in addition to further research and understanding of the impacts of climate change on sea level rise (including committed sea level rise from warming that has already occurred), resulted in a growing concern around future sea level at a 2 °C target. These concerns for AOSIS and other climate vulnerable countries building on scientific evidence from the IPCC 5th Assessment Report (including other impacts such as temperature extremes) fed into an expert led process under UNFCCC assessing the evidence related to 2 °C and found the 2 °C “guardrail” concept to be inadequate.

On 12 December 2015, the 196 parties at the 21st Conference of the Parties (COP21 – the UNs climate summit) adopted the Paris Agreement, which stated a goal to hold “The increase in the global average temperature to well below 2 °C above pre-industrial levels” and pursue efforts “to limit the temperature increase to 1.5 °C above pre-industrial levels.”

As well as the goal of a 1.5 °C limit becoming a stated target, the agreement stated “well below 2 °C” a change in tone from previous limits “of 2 °C”. The period defined as representing the “pre-industrial levels” was 1850-1900.

Does half a degree make any difference?

Figure 1 shows the differences in global mean warming over the whole year for a world that stabilises at either 1.5 °C, 2 °C or 4 °C. There are stark differences between the 2 °C and 4 °C worlds as you would well expect, but there are also noticeable differences between the 2 °C and 1.5 °C futures. In all three different warming level futures, the distribution of the amount of warming is varied across the world with a consistent pattern in all three futures. The greatest warming is projected over high latitudes, and on land compared to oceans in the mid-latitudes and tropics.

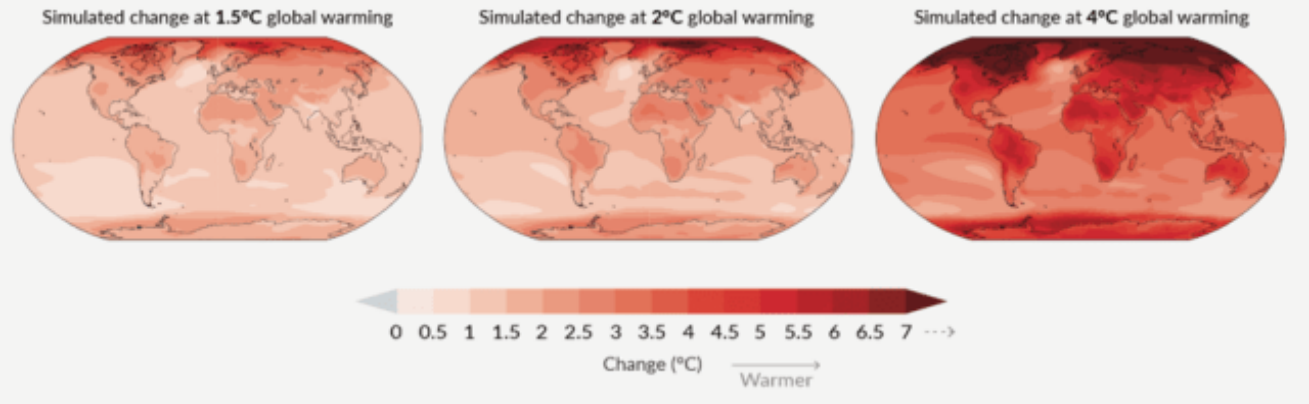

Simulated change at 1.5°C global warming
Simulated change at 2°C global warming
Simulated change at 4°C global warming
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7
Change (°C)
Warmer

Figure 1. Global mean surface temperature change for warming of 1.5 °C, 2 °C and 4 °C above the 1850-1900 baseline period. Figure modified from Figure SPM.5A from the IPCC 6th Assessment Report WGI Summary for Policy Makers.

Comparing the 1.5 °C and 2 °C worlds, the distribution of warming is consistent between the two different futures. However, the magnitude of some of these changes can also be quite large. There are some noticeable changes in the high Arctic particularly for the Russian and Canadian Arctic coastlines, with increases in warming of 2 to 4 °C for these regions. Elsewhere, there are increases of around 1 to 1.5 °C in the USA, Europe, parts of Australia and the Antarctic seas, while in South America, Saharan Africa, Southern Africa, the Middle East and central Asia increases could be around 2 °C.

From Paris to present

As a response to the Paris Agreement, the Intergovernmental Panel on Climate Change (IPCC) was commissioned to produce a Special Report on Global Warming of 1.5 °C. The report indicated that crossing the 1.5 °C threshold risks the occurrence of far more severe climate change impacts, including more frequent and severe droughts, heatwaves, and rainfall. The report noted higher impacts on biodiversity and the number of species extinctions (both on land and in the ocean) and a 10 cm higher rise in global mean sea level in the 2 °C compared to the 1.5 °C future world.

To assess the progress of countries towards the goals of the Paris Agreement, each year countries release their Nationally Determined Contributions, the promises each country makes outlining their pathway to Net Zero, with each five-year cycle of reporting seeing increasingly ambitious targets. You can review the 2023 report from the UNFCCC here.

Pathways to 1.5 °C

The Special Report also discussed the pathways to 1.5 °C future, and the associated risks of any overshoots in these pathways. Based on climate model projections produced for the report, the mean time by which the world needs greenhouse gas emissions to peak is before 2025 with a decline of 43%

(relative to 2019) by 2030, with Net Zero reached by 2050.

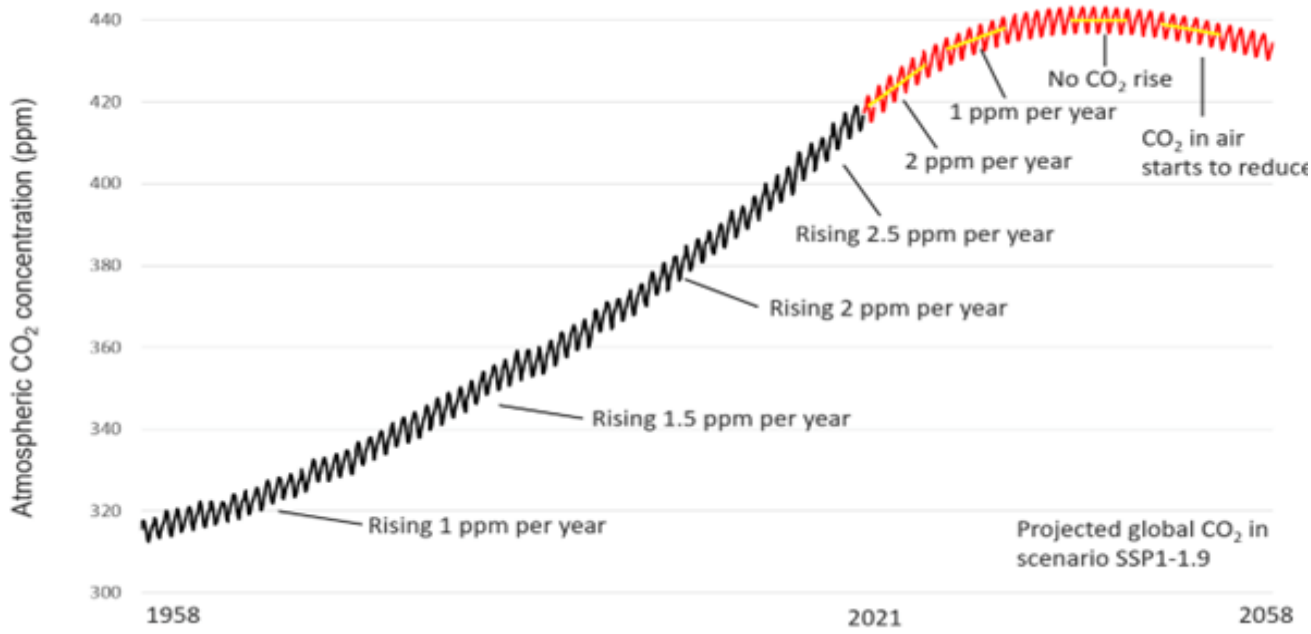


Figure 2 – A projection of the Keeling Curve showing the Mauna Loa Observatory record for atmospheric carbon dioxide from 1958 to 2021 (black line) and the projected pathway of this curve under SSP1-1.9 (red line), the SSP scenario that encompasses the 1.5 °C future.

A single year?

For the year to date, 2023 looks well on course to become the warmest year on record, and predictions for the next five years indicate a 66% chance of one of those years exceeding 1.5 °C. As such, it is useful to understand how an individual year greater than 1.5 °C sits within the concept of limiting warming to 1.5 °C. Essentially, the question being: “If we have a year warmer than this threshold, then has the target already been missed?”

The simple answer is no. We have seen individual months above 1.5 °C and in November 2023 some days above 2 °C, these events, even an individual year above 1.5 °C would not constitute a breach of the Paris Agreement goal. However, as recently highlighted in a paper by Met Office scientists led by Richard Betts highlighted that the concept of a 1.5 °C world not formally defined in the Paris Agreement, and outlined different approaches that could be used to define a formal metric in the future.

A standard approach* within climate science would be to define it based on a climatological mean of 1.5 °C, which would be defined over a period of 20 years. Using this approach and using the HadCRUT dataset, the most recent 20-year period (2003-2022) has a 20-year global mean temperature anomaly of 1.03 °C warmer than the pre-industrial period of 1850-1900. Within this period, individual year temperatures have ranged from 0.81 °C (2004 & 2008) to 1.27 °C (2016) warmer than the pre-industrial period.

The variability around the mean temperature is representative of the role of natural variability within the Earth’s climate (for example, the warming effect of El Niño vs the cooling effect of La Niña). A 1.5 °C future world will also experience these variations and therefore there will be years when the climate is

warmer and years when the world is cooler than 1.5 °C.

But, this same variability also means that in our present-day climate an individual year of 1.5 °C (or warmer) does not mean that we have reached the threshold of a 1.5 °C climate future. However, it is worth considering that whilst exceeding 1.5°C for a month or a year doesn't represent a failure to achieve the longer-term Paris Agreement target, it does indicate that we are getting closer, and urgent action is needed to mitigate future warming and to adapt to increasing climate risks.

[1] – The recent paper by Betts et al. highlighted the risk of this approach that it results in a delay to the recognition of a threshold being crossed, in the case of a 20-year mean, this is around 10 years delay. They highlighted that current IPCC research indicates that the 1.5 °C future will be reached in 2030, but the 20-year mean approach won't allow this to be formally recognised until 2040.

Date Created
December 2023

How is the winter weather shaping up?

Description

As we head towards Christmas there is, as always, a great deal of media and public speculation about what weather we might have in store for the festive season as well as the rest of winter.

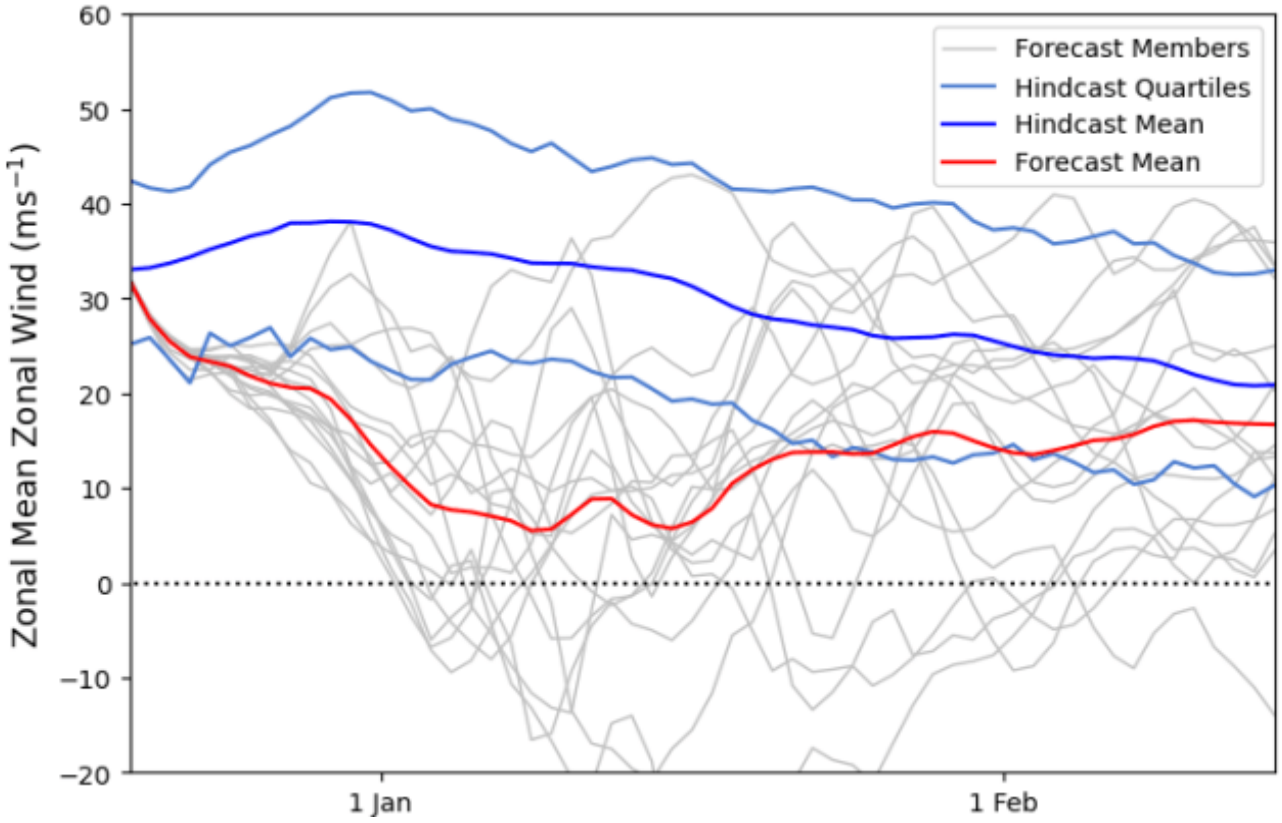
Starting with Christmas and the all-important question of whether it will be a white or not. Wintry showers are expected in the north which could technically make it a white Christmas, as we only need to see a single snowflake falling, but any lying snow will probably be confined to the mountains of Scotland. Elsewhere, showers are likely to fall mostly as rain, and so it's unlikely that we will see widespread or settling snow this year. So although technically it might be a white Christmas in a few places, don't get your hopes up for a picture-perfect white landscape. Looking towards the New Year, the weather looks to remain unsettled with low pressure bringing periods of breezy and wet weather for many.

To answer questions about the rest of winter, we need to look beyond the UK. The worlds' weather is interconnected, and there are large scale global drivers which we know have influences on UK weather at this time of year – so what are these doing at the moment?

A strong El Niño, the naturally occurring warming of the Pacific Ocean, is underway. This increases the likelihood that the second half of winter and early spring will be colder and drier than the first half.

The Stratospheric Polar Vortex is also weakening, which increases the chances of a Sudden Stratospheric Warming (SSW). A SSW often makes the jet stream (5 to 7 miles above the Earth) meander more, which can lead to the development of a large area of high pressure over northern Europe at the Earth's surface. This can 'block' the Atlantic low pressure systems, which often bring mild, wet and windy weather, from crossing the UK. Therefore, increasing the chance of cold, dry weather here and mild, wet and windy conditions for southern Europe. However, the impacts of an SSW on UK weather can also be benign, it does not always equate to cold weather, for example, in 2019, there was an SSW but little impact on the weather for the UK and NW Europe.

Stratospheric Polar Vortex strength 19 December 2023



Professor Adam Scaife, Head of Long-Range Forecasting at the Met Office, said: “There is an increased chance of an SSW occurring later this winter. Although any impacts will become clearer nearer the time, any effect on UK weather is most likely to occur in January and February.”

Another factor also influencing the UK this winter is the Quasi-Biennial Oscillation (QBO), a regular variation of the winds that blow high above the equator. It is currently in an easterly phase which also increases the likelihood of an SSW. Meanwhile, the current pattern of sea surface temperatures in the North Atlantic Ocean is also conducive to a reduction in the chance of westerlies. These effects are on a background of warming UK winters, consistent with wider global warming trends.

The science of longer-range and seasonal outlooks is at the cutting edge of meteorology and the Met Office is one of the leaders in scientific research in the area. However, even with ‘perfect’ prediction systems and ‘perfect’ meteorological observations, the fundamental chaotic nature of the atmosphere will still limit the skill of these predictions. Although, the science does not allow for specific detail on the amount of rain or snow over the coming months or exactly when severe weather may occur, long-range forecasts can provide useful information on the likelihood of possible conditions averaged over the UK for the season as a whole.

You can check the long range forecast and daily weather forecast on our website. You can also follow us on Twitter and Facebook, as well as on our mobile app which is available for iPhone from the App store and for Android from the Google Play store. Our three-month outlooks are updated each month. Keep track of current weather warnings on the weather warning page.

Date Created
December 2023

2023 in weather

Description

With temperature and rainfall records broken, red warnings issued and a flurry of named storms, 2023 has been another eventful year of weather for the UK.

While the full year's provisional weather and climate statistics will be available on 2 January, along with the full UK State of the Climate Report later in 2024, we take a look back at the moments that defined 2023's weather.

Our changing climate

With eight of the 12 months of the year warmer than average, 2023 will go down as one of the five warmest years on record for the UK, though the position for the full year will be announced on 2 January. This means the five warmest years in the UK series from 1884 include 2020, 2022 and 2023 – an indication of just how fast our climate continues to change.

As well as being much warmer than average, it has been a wetter than average year for most areas except western Scotland while for England and Northern Ireland this will be one of the ten wettest years on record in a series from 1836. Some areas have seen more than a quarter more rainfall than normal.

Met Office Senior Scientist Mike Kendon said: "The UK's highly variable weather means that every year is different. However, there are clearly some common themes: firstly, our climate is continuing to change dramatically – 2023 has been yet another very warm year, as well as wetter than average – and we expect this to continue in future decades. Secondly, we have broken a number of high temperature and rainfall records over the year, and this pattern is also consistent with our changing climate. Finally, as with every year, we have seen some extreme and impactful weather, particularly the run of named storms through the Autumn and in December.

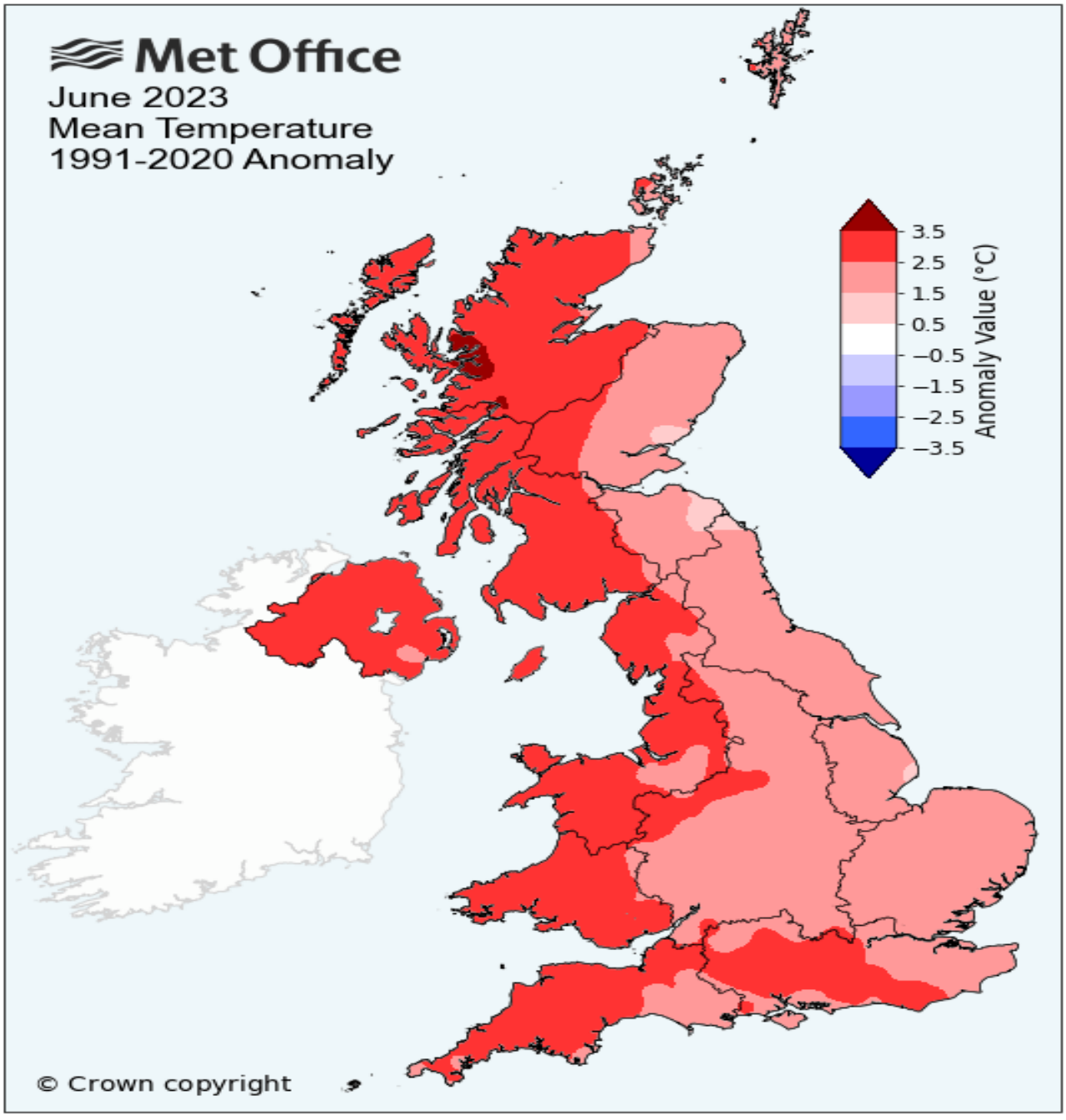
"2023 will be one of the five warmest years on record for the UK, although its exact position in the provisional figures will be confirmed in the new year."

Record breaking June

The lion's share of warm, dry, settled, sunny weather during the summer occurred in June – this being the warmest summer month (the last time this occurred was in 1966). Temperatures exceeded 30°C in the UK on five days in June, only one in July and none at all in August, with the highest summer maximum a modest 32.2°C compared to last year's unprecedented 40.3°C.

June 2023 was confirmed as the hottest June on record for the UK, something that was made more likely due to climate change, according to a Met Office attribution study.

The average mean temperature of 15.8°C in the month eclipsed the previous record for the Junes of 1940 and 1976 by 0.9°C, a huge margin. The UK monthly mean temperature was 2.5°C above the 1991-2020 average, this being the highest monthly anomaly since December 2015. Met Office scientists found that the chances of surpassing the previous record of 14.9°C had more than doubled since the period around 1940 due to human-induced climate change.



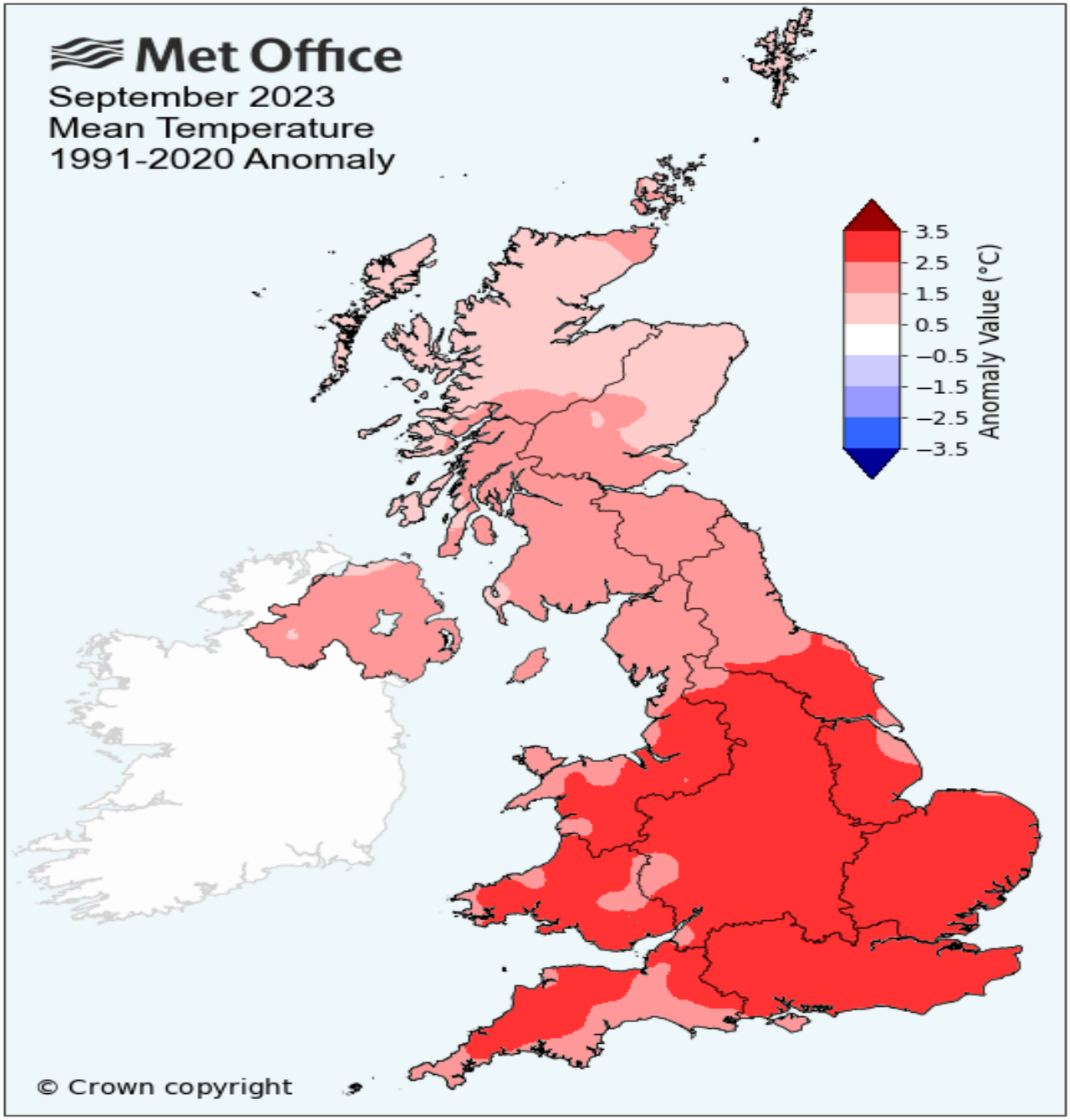
September warmth

Unusually, the two most prolonged spells of fine weather occurred in June and September, separated

by rather unsettled weather in July and August, including two named storms.

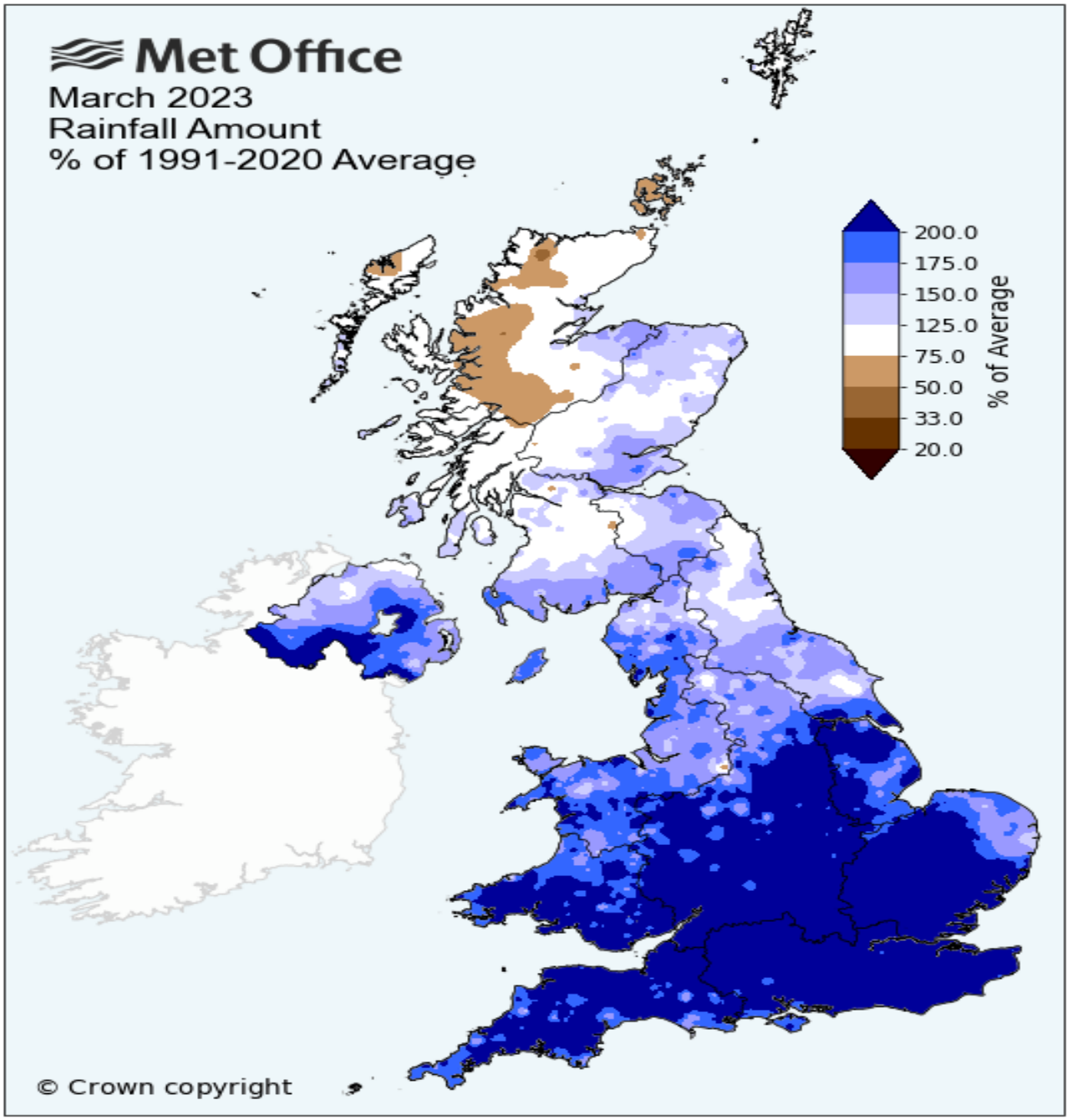
The early September heatwave saw temperatures exceeding 30°C somewhere in the UK for a run of seven consecutive days, a UK record. This resulted in the UK's joint-warmest September on record for the UK – and the warmest for England and Wales – in series which go back to 1884.

Temperatures peaked at 33.5°C at Faversham on 10 September, in what was the highest temperature recorded in the UK in 2023 – only the fifth time this has occurred in September in observational records.



A change in wet weather

With the UK’s sixth wettest March, sixth wettest July and equal sixth wettest October on record in series from 1836, overall this has been a wet year for most areas.



At the start of 2023, following the recording breaking warmth and relative lack of rainfall in 2022, water scarcity and drought were in the headlines. Through 2023, rainfall amounts were tracking relatively close to average, with drier spells in February and June compensated for by wet weather in March and July. Autumn rainfall has brought rainfall amounts to above average for most of the UK, following some

notable and impactful rain, especially in the east of Scotland.

Eastern Scotland had its wettest October on record, chiefly led by the exceptional rainfall brought on by Storm Babet.

Storms named… eventually

Storms have been named by the Met Office since 2015 in a joint initiative between the Met Office, Met Eireann and KNMI (the Irish and Dutch national weather services), to better communicate warnings of severe weather. For the 2022/23 season (from September 2022 to August 2023), the first storm to be named by the group happened in August 2023 – the longest wait since storm naming was introduced in the UK. However, Storms Otto and Noa, which were named by other storm naming groups, did impact the UK earlier in the year.

Seven storms have been named by the Met Office's group since 1 September, the fastest start to a storm naming season since it began in 2015, with the run of seven storms including Agnes (late September), Babet (mid-October), Ciaran (start of November), Debi (mid-November), Elin and Fergus (early December) and Gerrit (late December).

Storm Babet occurred during a prolonged period of very wet, unsettled weather and shortly after Scotland's wettest 2-day period on record on 6 to 7 October. Two red warnings for rain were issued by the Met Office, covering parts of eastern Scotland. For the county of Angus – coinciding with a red warning area – 19 October 2023 was, by a wide margin, the wettest day on record in a series from 1891. Babet caused widespread, extensive and severe flooding in many areas of all four nations.

2023 had several cold snaps, in the second half of January, early March and early December, with hard frosts and snow causing significant disruption at times (for example -16.0°C at Altnaharra, Sutherland on 9th March and 32cm at Buxton in Derbyshire on 10th March).

2023 also had an official White Christmas, which is defined as one snowflake falling in the UK on 25 December, though this was confined largely to high ground in the north of Scotland.

Seasons in review

Winter 2023 was drier, sunnier and slightly milder than average, with February particularly dry across England and Wales.

Spring 2023 brought into focus the shifting rainfall patterns around the UK; March was very wet in the south, in contrast May was drier than average in the north and west.

Summer 2023 was warmer and wetter than average with a record-breaking June.

Autumn 2023 was milder and wetter than average, with a fine start, a very wet October and a run of named storms.

December 2023 and the whole year's provisional stats will be published on 2 January, with the full UK State of the Climate Report planned to be released later in 2024.

Date Created

December 2023